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A Study on Cold Forging Die Design Using Different Techniques

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Abstract

It is becoming increasingly essential to predict the exact behavior of cold forging die during the forging process and it is also important to optimize the die design for its durability and to reduce the production cost of the die. Optimization of cold forging die design is required to reduce the production cost of die as well as the forged part and also to increase the accuracy of the die and the forged part. Since the past few years computer aided engineering (CAE) techniques have been widely used for research in metal forming. Amongst them finite element analyses (FEA) have been greatly successful to provide the understanding of metal flow and die stresses for different forming processes. The present work is a review of the existing die design techniques which are used in forging process to enhance the die design and to optimize die design process which will improve the performance of die. In cold forging the die will under go high loads, hence it is essential to know Fatigue behavior and Fatigue Failure of the die when it has been under go cyclic loading. The study end up with future challenges of the die design and its processes, the approaches adopted to develop an optimum system that can fulfill the customer demand.

Keywords: Cold forging die design, Stress, Deformation, Optimization, Forged part

1. Introduction

The forging is a process in which the work piece is shaped by compressive forces applied through various die and tools. It is one of the oldest methods in metalworking operations, dating back at least 4000 B.C. Forging were first used to make jewelry, coins and various implements by hammering metal tools made of stone. Many researchers have worked on cold forging, this paper emphasizes on cold forging die design and cold forged part. Different authors made an attempt to optimize the die design and to achieve the quality of forged part, for that they have used different techniques, like FEM, Nuaral Network, etc.

2. Literature Review

2.1 CAD/CAE used for modeling and analysis

FEM (Finite Element Method) has been adopted by many researchers for optimization of die design and die design process. This tool has been used to perform analysis of the die design parameters, and to get the accurate results without damaging any physical structure. The physical structure can easily be modeled in CAD package and then can be transferred to FEA package where the various analysis can be done. To optimize the product, one can easily change the geometry in CAD model to get the optimize geometry. Similarly the material properties also can be change. The researchers have excellently used these tools for the simulation. Many researchers made an attempt to give the solution for problem using the FEM, like Castro et al.(C. F. Castro , C. A. C. António and L. C. Sousa, 2004) made an attempt to obtain an optimal design in forging. The design problem is formulated as an inverse problem incorporating a finite element thermal analysis model and an optimisation technique conducted on the basis of an evolutionary strategy. A rigid viscoplastic flow-type formulation was adopted, valid for both hot and cold processes. In industrial forming processes most of the deformation energy is transformed into thermal energy. The generated heat causes the increase in temperature. External friction losses raise the temperature at the die–work-piece interface. To obtain optimal solutions Castro, C. A. C. António et al, used a developed numerical algorithm based on a genetic search supported by an elitist strategy. They chose design variables are work-piece preform shape and work-piece temperature. In order to demonstrate the efficiency of the inverse evolutionary search, specific forging cases are presented and they have consider the optimization of the process parameters aiming the reduction of the difference between the realised and the prescribed final forged shape under minimal energy consumption and restricting the maximum temperature.

Hyunkee Kim, Kevin (Hyunkee Kim, Kevin Sweeney and Taylan Altan, 1994) Sweeney have summarized the results of industrially relevant work in progress research with the DEFORM and DEFORM-3D FEM systems. They have been also studied a new tool design for cross groove inner race for a constant velocity joint, the flashless forging of an aluminum connecting rod, design of cold forgings and forming sequences, die wear in warm forging extrusion, and examples of DEFORM-3D simulations of a connecting rod, blade coining.

Hyunkee Kim and Taylan Alfan(Hyunkee Kim and Taylan Alfan, 1996) have given several examples of cold forged parts collected from literature and cold forging industry. For the example parts, forming process sequences, including the dimensions of the workpiece at each forming station, are given. They have been verified forming sequences generated by FORMEX with FE simulation program such as DEFORM.

T. Petersen and P. S. Frederiksen (T. Petersen and P. S. Frederiksen, 1994) have presented the results of two-dimensional finite element analysis with special emphasis on the effects of plasticity. The geometry treated concerns a die with rather sharp fillets, as found for example in a bolt-head die. They mainly examine stress concentration and propagation of the plastic zone in the fillet area as applied forging pressure increases. An automatic mesh generation routine is used in order to investigate different fillet designs and results of an optimization study are presented.

J.-H. Song Y.-T. Im (J.-H. Song and Y.-T. Im, 2007) have studied the process design for closed-die forging of a bevel gear used for a component of automobile transmission was made using three-dimensional finite element simulations. Process variables of the closed-die forging of the bevel gear were selected to be the pressing type, punch location, and billet diameter. Based on FE simulation results, appropriate process design without causing under-filling and folding defect was determined. In addition, with design of a die set including die insert and stress ring, cold forging of the bevel gear was experimented to estimate effectiveness of the designed process, the design process for the closed die forging of the bevel gear for the 3D FE analysis.

From experiments, they found that bevel gear with complete formation of the teeth was obtained without making any forming defects although flash in a forged product and punch fracture was occurred due to a slight difference in the punch stroke during formation. Through comparison of results between experiments and FE simulations, it was found that die clamping device clamping force and improvement of the die safety.

Chengliang Hu, Kesheng Wang et,al (Ravi Duggirala, Rajiv Shivpuri, Satish Kini, Somnath Ghosh and Subir Roy, 1994) have found three design schemes with different die shape. Firstly, finite element method is used to simulate the cold forging process of the spur gear with two-dimensional axisymmetrical model, and the strain distributions and velocity distributions are investigated through the post processor. Radial-flow-velocity distribution is an important indicator to be evaluated, and a relatively better scheme is selected. Secondly, three-dimensional simulation for the relatively better scheme is further performed considering the complicated geometric nature of gear, and the results show that the corner filling is improved and well-shaped gear is forged. Finally, a corresponding experiment is done, which is mainly utilized for supporting and validating the numerical simulation and theoretical investigation.

Young Suk Kim, Hyun Sung Son et,al, (Young Suk Kim, Hyun Sung Son and Chan Il Kim, 2003) have used rigid–plastic finite element simulation to analyze the deformation characteristic of the whole impeller hub forming processes and to optimize the process. As a result, two kinds of improvement for the impeller hub forming process satisfying the limit of the machine's load capacity and the geometrical quality are suggested and they verified their results with experimental results.

Takahiro Ohashi, Satoshi Imamura,et,al, (Takahiro Ohashi, Satoshi Imamura, Toru Shimizu and Mitsugu Motomura, 2003) have given the system which will designs one forging process and preform, and after then, it also does the internal profiles of dies and exports them as point line into general purpose CAD systems. Repeating the above procedures, the system generates process plans and die profile design from the product's shape to its raw materials. Multiple plans and profiles are designed by repeating the procedure recursively.

P. B. Hussain, J. S. Cheon,et,al, (P. B. Hussain, J. S. Cheon, D. Y. Kwak, S. Y. Kim and Y. T. Im, 2002) has used an inner gear component, clutch-hub, as an object for a numerical study investigating the usefulness and effectiveness of employing numerical simulations in the design process of metal forming parts. They have used CAMP*form* as computer-aided design simulation tool .They studied effect of shear friction factor on the forming process and it was examined using the most suitable die and workpiece geometries. They also, studied an aluminum alloys Al1100-O, Al2024-T3, Al6061-T4 and Al7075-T4 with respect to their defect factors of work hypothesis. They found that only Al6061-T4 could be considered as a substitute material of steel for cold forging of the clutch-hub.

T. Ishikawa, N. Yukawa,et,al, (T. Ishikawa, N. Yukawa, Y. Yoshida, H. Kim and Y. Tozawa, 2000) have discussed analytically the effects of forming stresses and generated heat on the dimensional change of punch die and work piece during forging. They have change in outer and inner diameter of backward extruded cup is investigated numerically using thermo-elastic-plastic FEM code according to the actual forging sequence, namely extruding, unloading of punch force, and ejection and air cooling of extruded cup. They got results of outer and inner diameters of product which are in good agreement with the experimental results. They have used the simulation to determine the initial tool dimensions for precision parts in the tool design process of cold forging.

C. S. Im, S. R. Suh, (C. S. Im, S. R. Suh, M. C. Lee, J. H. Kim and M. S. Joun, 1999) have worked on a computer aided process design technique, based on a forging simulator and commercial CAD software, has been presented together with its related design system for the cold-former forging of ball joints. The forging sequence design and its detail designs are generated through user–computer interaction using templates, design databases, knowledge-based rules and some basic laws. The forging simulation technique has been used to verify the process design. It has been shown that engineering and design productivity is much improved by the presented approach from the practical standpoint of process design engineers. Rong-Shean Lee, Quang-Cherng Hsu et, al, (Rong-Shean Lee, Quang-Cherng Hsu and Saint-Len Su, 1999) have worked to develop a computer-aided die design system using Auto-Lisp. The design characteristics of the die elements and the die assembly has been expressed in parametric form and programmed. They have proposed a system which has an open architecture, therefore, according to the system structure, die-design engineers can extent the die element design data base and programs. With the aid of the proposed system, the functions of die element design, die assembly design, automatic graphics and dimensions generation, redesign, dimension constraint correlations and bill of materials will provide efficiency and convenience of die.

B. Falk, U. Engel and M. Geiger (B. Falk, U. Engel and M. Geiger, 1998) have emphasized in their work to assess the applicability of different failure concepts for a closed cold forging die. The critical, process-dependent load is quantified and localized by using a finite element method. Based on the resulting stress–strain distributions, the damage parameters have been calculated yielding different estimates of tool life that are compared with practically experienced data.

D. J. Kim, B. M. Kim (D. J. Kim, B. M. Kim and J. C. Choi, 1997) have used neural networks to determine the initial billet geometry for the forged products using a function approximation. They have been used three-layer neural network and the back-propagation algorithm has employed to train the network. They have used simulated data to determine the aspect ratios that fill the die cavity. Hence the number of simulations has been reduced. By using the neural network they have predicted the unfilled volume for some aspect ratios they would not explored in the finite element simulation. They reduced the number FEM simulation in process planning.

W. L. Xu and K. P. Rao, (W. L. Xu and K. P., 1997) have carried out an analysis of isothermal axisymmetric spike-forging using an integrated FEM code. Simulations has been conducted to investigate the influence of different geometric parameters, processing variables and interfacial conditions on the instantaneous spike height. Their results of the simulations are discussed along with comparisons with available experimental results. They have given some guidelines for the design of this test has been drawn up.

Quang-Cherng Hsu and Rong-Shean Lee(Quang-Cherng Hsu and Rong-Shean Lee, 1997) have given a cold forging process design method based on the induction of analytical knowledge has proposed. They used analysis engine, which is a finite-element-based program, to analyze various multi-stage cold forging processes based on pre-defined process condition parameters and tooling geometry. Method which has been proposed by these authors is useful for the shop floor to decide the cold forging process parameters for producing a sound product within the required minimum quantity of the die set.

Hyunkee Kim, Kevin Sweeney et, al, (Hyunkee Kim, Kevin Sweeney and Taylan Altan, 1994) have summarized the results of industrially relevant "work-in-progress" research with the DEFORM and DEFORM-3D FEM systems. They also worked on a new tool design for cross groove inner race for a constant velocity joint, the flashless forging of an aluminum connecting rod, design of cold forgings and forming sequences, die wear in warm forging extrusion, and examples of DEFORM-3D simulations of a connecting rod, blade coining, and wire drawing of shapes.

Béla Lengyel, Ijaz A. Chaudhry,et,al, (Béla Lengyel, Ijaz A. Chaudhry and R. D. Hibberd, 1994) have worked on a new developments in the expert system COFEX ,for process planning in the cold forging of flanged round steel hollows. It has been written in PROLOG for IBM personal computers, implemented in modular form and linked to a finite element program. The finite element results show the development of the fold and indicate the boundary between conditions leading to acceptable and defective flange geometries.

In recent years, computer aided engineering (CAE) techniques have been increasingly applied with great success in metal-forming research, as well as in the cold- and hot-forging industry. Taylan Altan and Markus Knoerr (Taylan Altan and Markus Knoerr, 1992) have been adapted for cold-forging applications from an earlier publication (*J. Mater. Process. Technol.*, 33 (1992) 31–55) summarizes industrially relevant research results obtained with DEFORM. It has been reported on an investigation of a suck-in type extrusion defect, forging of bevel gears, stress analysis of forging tooling, design of multi-stage cold-forging operations, design of a net-shape cold-forging operation for pipe fittings and development of a new test to evaluate lubrication in cold forging.

S. I. Oh, W. T. Wu and J. P. Tang (S. I. Oh, W. T. Wu and J. P. Tang, 1992) have worked on features required to simulate cold forging operations are discussed. Example solutions are also presented to demonstrate the capabilities of the DEFORM system. It has been also shown that the automatic mesh generation and remeshing capability is an essential feature for industrial applications.

Markus Meidert, Markus Knoerr,et,al, (Markus Meidert, Markus Knoerr, Knut Westphal and Taylan Altan, 1992) have worked on, two modelling techniques, finite element (FE) based numerical modelling and physical modelling with plasticine, are being presented as process design tools in cold forging. They have developed a strategy to allow successful 2D FE modelling of bevel gear forging. They used the results from the process simulation then that they used it as a load input data for a punch stress analysis. Thus it has been possible to modify the punch geometry in order to reduce the punch stresses. They have been applied Physical modelling to verify the results of the 2D FE simulations.

Armin Buschhausen Klaus Weinmann (Armin Buschhausen, Klaus Weinmann, Joon Y. Lee and Taylan Altan, 1992) have worked on a friction test, based on a double backward-extrusion process, is proposed and examined in order to obtain information on lubrication quality. They have been used the program DEFORM, for FEM analysis conducted for different area reduction ratios and billet heights. They have been got simulated results are very close to the experimental results which has been performed in Germany some years ago. The reduction ratio that gives the greatest differences in extruded cup heights was selected for the test design and the influence of friction shear factors between m = 0.08 and m = 0.20 was investigated

Aly A. Badawy, P. S. Raghupathi,et,at, (Aly A. Badawy, P. S. Raghupathi, David J. Kuhlmann and Taylan Altan, 1992) have described a computer-aided system called "FORMING" for designing the forming sequence for multistage forging of round parts. FORMING can handle only solid round parts without protrusions. However, the program can be expanded to design forming steps for hollow parts and parts with internal protrusions that are forged without flash in upsetters, automatic forging machines, and vertical presses

Natsume,and Y., Miyakawa (Natsume, Y., Miyakawa, S. and Muramatsu, 1989) have studied systematically to understand the dimensional difference between forging tools and forged components has been tried by both experimental and FEM analysis. They have found that the difference is mainly influenced by the elastic deflections of the die and the elastic recovery of the forged part. The FEM analysis results from the consideration of the die as a deformable body are well agreed with the experimental results. They have been considered shrink-fitting factor. They have come know that when the shrink-fitting factor has adequately compensated, the analyzed dimensional difference results are well fitted to the measured data within the range of 1 μm.

Since the dimensional accuracy of forged parts are largely influenced by elastic behaviors of the tool material. Young-Seon Lee, Jung-Hwan Lee, et,al, (Young-Seon Lee, Jung-Hwan Lee, Jong-Ung Choi and T. Ishikawa, 2002) have evaluated the characteristics of elastic deformation at a forming tool for a cold forged alloyed steel by experimental and FEM analysis. Y. Qin, R. Balendra and K. Chodnikiewicz (Y. Qin, R. Balendra and K. Chodnikiewicz, 2000) have worked to combine coupled thermo-mechanical FE plastic simulation and heat transfer analysis to define heat-flux-density functions across die/workpiece interfaces. The functions were then used for initiating heat transfer analysis on the die with the repeated heat-loading for the given cycles. Since only heat transfer analysis was required for the die for the multi-cycle analysis, high-efficiency of the computation has achieved.

2.2 Micro Genetic Algorithm

To optimize the cold forging design design process some the authors have been used the Micro Genetic Algorithm like Ravi Duggirala, Rajiv Shivpuri,et,al, (Chengliang Hu, Kesheng Wang and Quankun Liu, 2007) have used the finite element analyses for providing the successful understanding of metal flow and die stresses for different forming processes. To minimize the possibility of the initiation of tensile fracture in the outer race preform of a constant velocity joint manufactured by cold forming operations, an adaptive Micro Genetic Algorithm has implemented. The chosen design variables were the preform diameter, the maximum number of forming operations, the number of extrusion and upset operations, the amount of area reduction in each pass, the amount of upset in each upset, and the included angles in the extrusion and upset dies. Significant reduction in the maximum damage value was achieved as a result of this optimization process.

A new method have been described by S. Roy, S. Ghosh, et,all, (S. Roy, S. Ghosh and R. Shivpuri, 1997) for design optimization of process variables in multi-stage metal forming processes. The selected forming processes are multi-pass cold wire drawing, multi-pass cold drawing of a tubular profile and cold forging of an automotive outer race preform. An adaptive micro genetic algorithm (μGA) scheme has been implemented for minimizing a wide variety of objective-cost functions relevant to the respective processes. The chosen design variables are die geometry, area reduction ratios and the total number of forming stages. Significant improvements in the simulated product quality and reduction in the number of passes has been observed as a result of the micro genetic algorithms-based optimization process.

2.3 Inverse Approach

Some of the researchers have been applied an inverse approach to the preform shape optimization problem. R. Di Lorenzo and F. Micari (R. Di Lorenzo and F. Micari, 1998) made an attempt to ensure that in the finishing step to obtain the desired product without shape defects such as underfilling or folding and with a minimum material loss into the flash in closed die forging. The preform design plays a critical role for the success of the process. They have been applied an inverse approach to the preform shape optimization problem. The method permits to evaluate a response function which links the set of parameters defining the preform shape with the fulfillment of the product design specifications. They have been applied their approach to a closed die forging process aimed to the production of a C-shape component, and has allowed to determine the optimal preform geometry which ensures the complete filling of die cavity . R. Di Lorenzo and F. Micari (V. Maegaard, 1985) have applied an inverse approach to the preform shape optimization problem: the method permits to evaluate a response function which links the set of parameters defining the preform shape with the fulfillment of the product design specifications. They have been applied their approach to a closed die forging process to the production of a C-shape component, and has allowed to determine the optimal preform geometry which ensures the complete filling of the die cavity.

Researchers have worked on cold forging die design and the die design process to achieve the optimal die design and the optimal die design process, they have adopted different techniques and methods like model-material technique, least squares, physical modeling slab-analysis method upper-bound technique, and matrix method.

Upper-bound technique Boundary Element Methods, finite difference method and some researchers have used the experimental approach and numerical methods which have been discussed. V. Maegaard (V. Maegaard, 1985) has studied the parameters which limit the forging process are the maximum press force available and the contact pressure between the workpiece and the tool. Researchers can make use of this knowledge for a better understanding of the prevailing process mechanics and for improvement of the forging process, whilst the production engineer can use this knowledge for the selection and allocation of process steps. Furthermore, determination of contact pressure facilitates understanding of tool wear and fracture, of the plastic flow behaviour of the materials, and of the necessary radial and/or axial splitting and pre-stressing of the tooling. The different design parameters for a rod/cup component are discussed and experimental results are presented, particularly for the contact pressure on the die surface in forward/backward extrusion, using the model-material technique. T. Ohashi, A. Nakata, et,al, (T. Ohashi, A. Nakata, 2001) have intended to use a to analyze the qualitative accuracy of a multi-body machine system, part of which receives a large changing external load, the Improvement in process of cold forging die design with analyzing qualitative accuracy.

Jens Groenbaek and Torben Birker (Jens Groenbaek and Torben Birker, 2000) have studied the demand of the market to the major industrial cold forgers for the development and production of complicated net shape parts at fairly low unit costs which requires an innovative new die designs for the optimisation of die deflections. They reduce the die deflection by 30–50% in critical dies so that die lives can be improved by factors of 3–10.they applied the high-stiffness STRECON E^+ containers influence the stresses, strains, and deflections in critical dies. They showed how the STRECON® E^+ containers can be applied to such critical dies like bevel gear dies, planetary gear wheel dies, and spline dies in an innovative way.

Chen, R. Balendra, et, al, (Chen, R. Balendra, and Y. Qin, 2004) have used relevant technologies depend on tools in which error-compensation can be affected. To minimise the component errors have presented the novel die-design approach, known as the least squares approach, has been used and Shrink-fitting compensating die structure has been employed. The errors caused by die-elasticity, secondary yielding, springback and temperature were considered in the process of minimisation.

The main factors that may influence the accuracy of the optimisation procedure has analysed. The final component errors have been controlled to within a few micrometers ie 1 μm. The approach has been illustrated using axisymmetric closed-die forging. H.S. Kim, (H.S. Kim, 2007) has proposed a cold forging process sequence in order to produce the terminal pin as one piece. The plate-shaped head section requires an upsetting in the lateral direction of a ylindrical billet, which is followed by a blanking process.The intermediate forgings obtained by experiments of the preform forging stage and the final forging stage, respectively, by using the proposed cold forging process sequence, the head and the body section could be produced as one piece without any defects.

K. D. Hur, Y. Choi,et,al, (K. D. Hur, Y. Choi and H. T. Yeo, 2003) have found that the use of high stiffness materials to the first stress ring of forging dies can reduce the elastic deformation of die insert without failure. Yi-Che Lee and Fuh-Kuo Chen (Yi-Che Lee and Fuh-Kuo Chen, 2001) have selected four die materials commonly used in the cold-forging process which has been examined to obtain the relationship between the hardness and the die fatigue life. They first heat-treated die materials by a developed process to obtain different values of hardness, and the ductility has been retained at a favorable level. The material properties of these die materials were then obtained from tension and impact tests. The relationship between the mechanical properties and the hardness has established. They also worked to build up theoretical model which will predict the die fatigue life.

W. G. Cho and C. G. Kang (W. G. Cho and C. G. Kang, 2000) have studied the filling behavior and various defects of products has observed, and microstructures and mechanical properties were investigated along with parameters such as pressure and die temperature. The porosity, which is an internal defect, has observed by the researchers particularly at lower die temperatures. A dense microstructure has been found at lower die temperature and higher applied pressure. In a tensile test, they have observed that the higher the applied pressure, the higher the ultimate strength, yield strength, and elongation. In a hardness test, it has been observed that the hardness decreased gradually from the center to the periphery of the specimen.

John Walters, Wei-Tsu Wu, et,al, (John Walters, Wei-Tsu Wu, Anand Arvind, Guoji Li, Dave Lambert and Juipeng Tang, 2000) have worked on Recent development of process simulation for industrial applications. The application of process simulation, as applied to the forging, cold heading and heat treatment has been discussed. Several applications are presented, with an emphasis on industrial cases.

Victor Vazquez and Taylan Altan (Victor Vazquez and Taylan Altan, 2000) have summarized the results of industrially relevant work-in-progress they have done research with numerical and physical modeling systems. They worked on a tool design for the forging of a cross groove inner race for a constant velocity joint, and the design of a tooling to forge a connecting rod without flash. Hong-Seok Kim and Yong-Taek Im (Hong-Seok Kim and Yong-Taek Im, 1999) have worked on a methodology of applying the searching technique for process sequence design. The flexibility of the introduced searching technique has been evaluated by generating design examples of a shaft part, a wrench and hexagonal bolts of AISI 1045.

B. I. Tomov and V. I. Gagov (B. I. Tomov and V. I. Gagov, 1999) have given comprehensive description of some die forging operations selected as representative steps for the near-net-shape forging of spur gears. The main results are obtained on the basis of quasi-static model material experiments that have been applied to collect data needed for statistical processing or to verify some analytical solution and computer simulations. These results could be helpful in engineering practice for simple calculations in process planning design.

P.F. Bariani, G. Berti**,** (P.F. Bariani, G. Berti, L. D'Angelo and J.J. 1998) have done research on an integrated approach to the computer-assisted design of the tooling systems and identification of appropriate setting conditions and timing for multi-station presses to be used in cold, warm and hot forging.

Their approach is based on (i) the classification of possible configurations of punch- and die-side tool subassemblies, (ii) the automatic retrieval of the tool-holder assembly configuration for the specific station of the press, (iii) the assembly rules and automatic scaling and fitting of individual tool components and (iv) the animation -with check for interference- of die, punches, slugs, grippers and ejectors according to the kinematic model of the press.

L. S. Nielsen, S. Lassen ,et,al, (L. S. Nielsen, S. Lassen, C. B. Andersen, J. Grønbæk and N. Bay, 1997) have described a flexible tool system, which makes it possible to operate with the eight basic cold forging processes, forward rod extrusion, backward can extrusion, forward tube extrusion, open die reduction, ironing, coining, upsetting and heading by changing only a few component specific tool parts like punch, die and ejector, whereas all other tool parts are standard, applicable for many different tool set-ups, thus minimizing the tool costs and the design lead time. The tool exchange time has been minimized by developing special quick tool change systems for punches and dies and a tool positioning system of the hard stop type.

S. Choi, K. H. Na and J. H. Kim (S. Choi, K. H. Na and J. H. Kim, 1997) have worked on rotary forging an incremental forming processes, is a cost-effective forming method for the cold forging of intricate parts to net shape. They have been conducted the experiments which are carried out with carbon steel (AISI1020, AISI1045) and aluminium (6061) and the results then compared with theoretical results. Their analysis seems to be available for the prediction of the forming force and to investigate the influence of the forming parameters on the design of the forging process. Yuichi Nagao , Markus Knoerr et,al, (Yuichi Nagao, Markus Knoerr and Taylan Altan, 1994) have been analyzed the stress states that exist in the inserts during the forming operation and determines the causes of the fatigue failures. They have verified design concept by a specially designed laboratory forging test. They concluded from the test results which show that the stress state in a die can be reduced with the new tooling concept and that the fatigue failure can be avoided.

J. M. Monaghan (J. M. Monaghan, 1993) has worked on an experimental and theoretical analysis of the metal deformation arising during the cold forging of countersunk headed fasteners. The author has derived the expression for the punch—workpiece interface and the mean forging pressure using the slab-analysis method. He had been found that the slab-analysis expressions predicted results are very closer with experimental results.

T. Nagahama and S. Enomae (T. Nagahama and S. Enomae, 1992) have concentrated on the hardware aspects of forging technology in Japan, relating in particular to the automotive industry. They have been studied the market trends in forming methods and press capacity, the requirements for cold- and warm-forging presses, the design and performance characteristics of a number of different types of commercially available forging presses; the process and main features of warm forging, including die life and die lubrication; and different types of forging systems and forging devices, including a die lubricating device, a quick die changing system, and an enclosed-die forging system. Examples of parts produced by cold and warm forging are presented and discussed.

John A. Pale Rajiv Shivpuri et,al**,** (John A. Pale, Rajiv Shivpuri and Taylan Altan, 1992) have reviewed the recent developments in cold forming tooling, machines and processing. They have primary focused on forming complex parts which often required a combination of forward, backward and radial extrusion, using novel multi-action tooling and forming equipment. G. Maccarini, C. Giardini**,** (G. Maccarini, C. Giardini, G. Pellegrini and A. Bugini, 1991) have particularly concerned the results obtained when the fillet radius of the die was varied and then tested in a process of extrusion forging. The rake angle of the extrusion hole provides a solution similar to the devices actually in use. They have been used the well-known matrix method which has first introduced by professor Kobayashi to study theoretically the problem of filling the die cavity during cold forging of copper.

J. M. Monaghan (J. M. Monaghan, 1988) has investigated the coining stage of a closed-die axisymmetric cold-forging operation. He had used an upper-bound technique to establish a generalised expression capable of being used in conjuction with a small computer or programmable calculator for the calculation of forging loads. He had also investigated an influence of preform geometry on die corner fill-out, the results shows that while initial preform geometry does not significantly influence the material flow at the final stages of fill-out, it does influence the maximum loads required to achieve complete die-filling. K. Sevenler, P. S. Raghupathi (K. Sevenler, P. S. Raghupathi and T. Altan, 1987) have been described the development of a prototype expert system for forming-sequence design in cold and warm forging of axisymmetric parts. The different design parameters for a rod/cup component are discussed by V. Maegaard (V. Maegaard, 1985) and he had presented experimental results, particularly for the contact pressure on the die surface in forward/backward extrusion, using the model-material technique.

S. A. Tobias (S. A. Tobias, 1984) has reviewed the field of high energy rate bulk forming, considering the machine advantages and the process advantages in relation to conventional machines; the different types of HERF machines and their respective industrial roles; the economics of HERF hammers; and finally HERF processes. He had reviewed on both the machines and the processes which are illustrated by numerous figures, and there is extensive reference to relevant published literature. (S. K. Biswas and K. Mallikarjuna Rao, 1984) S. K. Biswas and K. Mallikarjuna Rao have been investigated; flow in plane-strain extrusion-forging has investigated. They have been chosen dies so as to allow lateral flow in only the inward direction.The modelling of this elementary process by the present method is simple in concept and execution. The demonstrated overall validity of this approach recommends its use for predicting flow in more complex configurations and ultimately as a tool of the practising engineer for industrial die and process design.

T. Tran-Cong and N. Phan-thien (T. Tran-Cong and N. Phan-thien, 1988) have worked on simple technique to design extrusion dies for three dimensional profiles based on Boundary Element Methods has reported. They have applied this technique to design a few dies for triangular and square Newtonian extrudates. They have been compared the obtained results with the available data on common design practice. Mingwang Fu and Baozhong Shang (Mingwang Fu and Baozhong Shang, 1995) havebeen developed a boundary-element method (BEM) program used to assess a doubly-reinforced die for the precision forging of a bevel gear. According to their program, the characteristics of the BEM program are given. On the basis of the results calculated by the use of the BEM, the region of dangerous stress has been determined and the effect of the amount of interference on the distribution of stress is revealed. S. Shamsundar, A. G. Marathe et,al, (S. Shamsundar, A. G. Marathe and S. K. Biswas, 1984) have wrought a computer code using finite difference method to estimate temperature histories and validated by comparing the predicted cooling of an integral die-billet

Liu Qingbin, Fu Zengxiang, Yang He,et,al, (Liu Qingbin, Fu Zengxiang, Yang He and Wu Shichun, 1997) have employed a numerical simulation technique to study the thermal behavior of the high-speed forging of an AISI1045 disk. They have been found that die-chilling and some forging parameters have a key effect on the forging process and even on the final product shape. They also found that through the optimization of the forging parameters, an optimum forming processing can be selected before the component is put into production. Heon-Young Kim, Joong-Jae Kim ,et,al, (Heon-Young Kim, Joong-Jae Kim and Naksoo Kim, 1994) have been worked to obtain quantitative information regarding hot closed-die forging, especially in respect of the material flow, the die pressure, and the temperature. For the study of the flow, layered plasticine was used in physical modeling with a half-scale die set. For the numerical simulation, a thermoviscoplastic finite-element program has been developed. Pressure and temperature distributions are obtained at each stage. The temperature changes in the workpiece and the dies per process cycle are simulated. It has been expected that the information can be used in the design of preforming operations to reduce the forging load and to enhance the die life.

Yuichi Nagao, Markus Knoerr (Yuichi Nagao, Markus Knoerr and Taylan Altan, 1994) have analyzed the stress states that exist in the inserts during the forming operation and determines the causes of the fatigue failures. They have been verified the design concept by a specially designed laboratory forging test. Then they found that the test results shows the stress state in a die can be reduced with the new tooling concept and that can be avoid fatigue failure. G. Sutradhar, A. K. Jha et,al, (G. Sutradhar, A. K. Jha and S. Kumar, 1995) have reported on an investigation into various aspects of cold forging of iron-powder preforms. An upperbound solution has constructed for determining the die pressures developed during the cold forging of iron powder under axisymmetric and plane-strain condition. They have been discussed critically obtained results to illustrate the interaction of the various parameters involved and are presented graphically.

Mark RobinsonHoward A. Kuhn (Mark Robinson and Howard A. Kuhn, 1978) have worked on workability analysis that can predict the surface cracking which has been applied to the types of deformation that would occur during cold forging of a gear. They have been applied the workability analysis to both stages to determine the effect of process variables on the likelihood of surface cracking. They have considered process variables in their study are preform geometry, die geometry and die-workpiece friction.Results have been used to formulate preform-design guidelines for different types of gears, including pinions, ring gears, and spur gears. A criterion to predict wall instability during upsetting of a ring has also presented.

M. Arentoft, T. Wanheim, et,al, (M. Arentoft, T. Wanheim, M. Lindegren and S. Lassen, 2005) have worked on Reversed straining in axisymmetric compression test .Because of reversed plastic deformation of the work-piece will effect on the resulting diameter of the work-piece. In order to simulate these conditions a reversed axisymmetrical material tester has designed and constructed. They have been tested three different materials, aluminum alloy AA6082, technically pure copper (99.5%) and cold forging steel Ma8, at different temperatures found during cold forging.

P. Huml, D. Zonghai et,al, (P. Huml, D. Zonghai and Y. Wei, New, 1997) have aimed at describing a new model of strain hardening applied in metal forming analysis. Their model allows better prediction of flow stress under cold forming conditions. The application of the incrementally formulated flow stress model is exemplified for prediction of metal flow, loads and temperature distribution in cold forming processes like cold rolling, wire drawing, cold forging.

3. Conclusions

This paper gives a review of optimization of cold forging die design and dies design process. Cold forging die design and die design process optimization has been done by many authors using different techniques excellently. Still it is require getting the higher accuracy in the results, which can be achieved by optimizing the meshing and finding out the optimal aspect ratio of the elements by using Nueral Network for CAD/CAE die models. Secondly the couple field analysis has to be done to know the exact behavior of die when it has been undergo various types of loads. In cold forging the die will under go high loads, hence it is essential to know Fatigue behavior and Fatigue Failure of the die when it has been under go cyclic loading.

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